cumulus as the approaching wedge of cold air behind the squall line compresses the SW. wind laterally. (*M*, fig. 2.)

The squall-line cloud curtain and downward-boiling cloud.—In the west or northwest a low arch of dark cloud comes over the horizon; in a few minutes the wind dies down, and scud in the northwest may be seen rapidly approaching. The arch rises rapidly, and as it passes the zenith it stretches as a straight curtain from horizon to horizon; the northwest squall arrives. Soon the ragged foot of the curtain is silhouetted against the light eastern sky. All along the line, but especially at two or three places, little flecks of cloud suddenly appear just below it and rush up into it as if drawn by a magnet. (*N*, fig. 2.) The cold air from the northwest is forcing the warm air immediately in front to rise at a vertical rate of 5, 10, or more, meters per second. Overhead is a downward-boiling, festooned cloud marking the turbulent wind boundary at the top of the squall. (*O*, fig. 2.)[3] An occasional drop of rain reaches the earth.

Heavy rain resulting from strongly forced ascent.—As the light streak in the east becomes a mere line, rain is setting in, perhaps with a thunderstorm. (*P*, fig. 2.) The heaviest shower of the weather cycle falls during the next quarter of an hour or hour, and as this passes off and the clouds begin to break, the surface wind becomes lighter on account of the backward flow of air from the heavily falling rain. Broken clouds at low levels travel from the NW., and, higher up, from the SW. (*Q*, fig. 2.) As the NW. wind strengthens again compression-forced ascent and surface turbulence form low clouds again, which soon become more or less rounded on top (*R*, fig. 2) by thermal convection as colder air quickly arrives just above the slower-moving air dragging over the surface. After a few hours the precipitation finally stops and the breaking alto-stratus, moving rapidly from the SW., reveals several layers of clouds. (*S*, fig. 2.) In long, changing SW. to NE. lines these last indications of the forced ascent of the SW. wind by the underthrust of the NW. wind gradually pass toward the eastern horizon.

The turbulent strato-cumulus caused by thermal convection; snow flurries.—During the afternoon the lower clouds have become well-defined strato-cumulus (*I*, fig. 2), which disappear at sunset. Before daybreak, however, the semi-stagnation of the surface air and the consequent acceleration of the wind just aloft relieved from the surface drag, has allowed the vertical temperature gradient to become adiabatic, whereupon the wind aloft engages the surface wind and with sudden gusts gets under it and raises it, quickly forming strato-cumulus. After sunrise, the heating of the surface air may intensify this convection and make denser and denser strato-cumulus clouds, from which smudges of falling snow cover the sky (*U*, fig. 2) and occasionally reach the surface as light flurries.

Wave-made, lenticular alto-stratus caps.—The relatively slow-moving convectional masses of air from the clouds so interfere with the free sweep of the winds aloft that they are thrown into waves which disturb the upper boundary of the cold, northwest wind, and, not infrequently, force up this moist layer sufficiently to form long lines of lenticular altro-stratus immediately over the strato-cumulus. These lenticular clouds are sometimes remarkably sharp where forming in front (just before the crest of the wave) and often break into detached wave clouds (waved from SW. by warm current above) where evaporating in the rear. (*V*, fig. 2.)

Temperature prognostics from time of occurrence of strato-cumulus.—Unless the strato-cumulus clouds disappear at or before sunset, colder and colder air is still arriving aloft and a colder night is in store. If no strato-cumuli form on the next morning till several hours after sunrise the cold wave is broken, and a new weather cycle is about to begin.

[3] Cf. fig. 10, ibid., p 400.

CONCLUSION.

It is evident from studies of the appearance and transformations of cloud forms that the different types of clouds are very closely interrelated and pass from one to another form without any recognizable dividing line.

Since our weather is largely the result of the interaction of over- and under-running winds, clouds as indices of such are valuable in showing what is going on and what is to be expected. Cloud observations are finely complementary to pilot-balloon observations, for which there must be clear air and a lack of even intermittently intervening clouds. The whole domain of meteorology has no easier, more interesting, or more promising aspect for observation and study than clouds.

ATMOSPHERIC WAVES.

By F. Trey.

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This note presents the results of a study, by means of kites equipped with meteorographs, of the conditions in the neighborhood of cloud strata, on days when there were present well-defined alternating bands of cloud. The observations were carried out at the Aerological Observatory of Pawlowsk, and are summarized in the following table:

1	2	3	4	5	6	7	8	9	10	11	12
				Wave length.			Height above ground.			Direction: N=0°, E=90°.	
Date.	Temperature, lower layer.	Difference, upper-lower layer.		Registered.	Measured.	Computed.	Waves.	Clouds.	Clouds—type.	Observed.	Computed.
1918.	° C.	° C.	m.p.s.	m.	m.	m.	m.	m.		° °	° °
Jan. 17.	−18	+ 4.8	5.5	550	......	550	800	480	Nb.	90-270	85-265
18.	−20	+ 5.1	5.2	......	570	460	800	520	St.	75-250	79-259
18.	−18	+ 1.0	5.0	2,060	......	2,300	1,400	......	......	......	......
21.	− 5	+ 5.4	6.0	660	......	590	300	230	Nb.	......	......
21.	0	− 2.4	5.0	940	......	900	1,000	......	......	......	......
22.	1	+ 5.2	4.5	360	......	350	400	360	St.	......	......
24.	−15	+ 6.3	7.0	720	......	690	130	......	......	......	......
24.	− 9	+ 1.3	2.5	360	......	420	1,300	......	......	......	......
24.	−14	+ 0.8	3.0	990	......	900	2,400	......	......	......	......
25.	−14	+13.4	9.5	700	......	600	200	......	......	140-320	152-332
Feb. 1..	− 1	+ 6.0	8.5	1,000	1,200	1,070	250	150	St.	44-220 48-210	44-224
2..	− 5	2.7	8.0	......	......	2,200	350	......	......	......	......
3..	......	......	......	......	......	......	......	......	......	48-235	55-235

The observations showed the presence of a more or less sharp surface of discontinuity, above and below which lie several hundred meters of air in which cloud formation takes place. There is then a gradation into a region with the normal temperature gradient. In the disturbed strata occur small but very regular temperature variations which cause waves on the thermogram. It will be noticed that in all but one case a warmer layer is gliding over a colder one.

The data in colums 2, 3, 4 were recorded by the meteorograph; those in columns 6, 8, 9, 10, 11 were obtained by observations from the ground, together with the direction of the wind in each layer of air. Columns 7 and 12 can then be computed. Column 5 was taken from the thermogram. See Wegener, *Thermodynamik der Atmosphäre*, pp. 155-162, 1911.—*E. W. W.*